PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:	Confirmation No. 1837
James A. DiCARLO, et al.	Examiner: Carlos N. Lopez
Application No.: 10/777,630	Group Art Unit: 1791
Filed: February 13, 2004	Attorney Dkt. No.: 061011.00006

For: METHODS FOR PRODUCING HIGH-PERFORMANCE SILICON CARBIDE FIBERS, ARCHITECTURAL PREFORMS, AND HIGH-TEMPERATURE COMPOSITE STRUCTURES

DECLARATION UNDER 37 C.F.R. § 1.132

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

I, Dr. James A. DiCarlo, residing at 29511 Huntington Drive, North Olmstead, OH, 44070, hereby declare that:

(1) I hold a B.S. in physics from Canisius College, a PhD in solid state physics from the University of Pittsburgh, and that I undertook and completed post-doctoral studies in the field of radiation damage at Brookhaven National Laboratory. I also am a member of the American Ceramic Society, the American Physical Society, the Metals and Materials Society (TMS) and ASM International.

(2) I am a Senior Technologist in the Materials Division at NASA Glenn Research Center where I have worked for over 40 years on the deformation and fracture mechanisms of structural materials. I have gained international recognition in the area of understanding and modeling the properties and time/temperature mechanical behavior of ceramic fibers and ceramic matrix composites. I have received the NASA Medal for Exceptional Scientific Achievement, I am a Fellow of the American Ceramic Society, and I recently won an R&D-100 award for a new high-performance SiC fiber. Currently, I am the technical leader for the NASA research team concerned with ceramic composite development for hot-section components in advanced gas-turbine engines for aero and space propulsion.

(3) I am the author or co-author of over 150 scientific and technical publications. Some of my recent publications include:

- J.A. DiCarlo and H.M. Yun: Fiber Test Development for Ceramic Composite Thermomechanical Properties, *Mechanical, Thermal and Environmental Testing and Performance of Ceramic Composites and Components, ASTM STP 1392,* M. G. Jenkins, E. Lara-Curzio, and S. T. Gonczy, Eds, American Society for Testing and Materials, West Conshohocken, PA, 2000, pp. 134-147.
- D. M. Wilson, J. A. DiCarlo, and H.M. Yun: Ceramic Fibers, chapter in *ASM Handbook, Volume 21 Composites*, ASM International, Materials Park, Ohio, 2001, pp. 46-50
- J.A. DiCarlo and H.M. Yun: Creep of Ceramic Fibers: Mechanisms, Models, and Composite Implications. *Creep Deformation: Fundamentals and Applications*, eds. R.S. Mishra, J.C. Earthman, and S.V. Raj, The Minerals, Metals, and Materials Society, Warrendale, PA, 2002
- J.A. DiCarlo and H.M. Yun: Modeling the Thermostructural Capability of Continuous Fiber-Reinforced Ceramic Composites. J. Eng. Gas Turbines and Power, 204 (2002), pp. 465-470.
- J.A. DiCarlo, R.T. Bhatt, and T.R. McCue: Modeling the Thermostructural Stability of Melt Infiltrated SiC/SiC Composites. Cer. Eng. Sci. Proc., 24 (2003), pp. 465-470.
- J.A. DiCarlo, H.M. Yun, and J.B. Hurst: Fracture Mechanisms for SiC Fibers and SiC/SiC Composites under Stress-Rupture Conditions at High Temperatures. Applied Mathematics and Computation, 152 (2004), 473-481.

- J.A. DiCarlo, H-M. Yun, G.N. Morscher, and R.T. Bhatt: SiC/SiC Composites for 1200°C and above, NASA/TM-2004-213048, 2004.
- DiCarlo, J.A. and van Roode, M.: "Ceramic Composite Development for Gas Turbine Engine Hot Section Components", Paper GT2006-90151, *Proceedings of ASME Turbo Expo 2006: Power for Land, Sea and Air*, May 8-11, 2006, Barcelona, Spain.
- DiCarlo, J.A., Yun, H.M; and Bhatt, R.T.: "Advanced SiC/SiC Ceramic Composite Systems Developed for High-Temperature Structural Applications". Research & Technology 2005, NASA/TM--2006-214016, pp. 120-121.
- Lang, J. and DiCarlo, J.A.: "Modeling Creep-Induced Stress Relaxation at the Leading Edge of SiC/SiC Airfoils", *Proceedings of the 31st Annual Conference on Ceramics, Metal & Carbon Composites, Materials and Structures*, Cape Canaveral, Florida, January 2007
- Morscher, G.N.; DiCarlo, J.A.; Kiser, J.D.; and Yun, H.M.: "The Effect of Fiber Architecture on In-Plain Stress-Strain Behavior in Sylramic-iBN Melt-Infiltrated SiC Matrix Composites", *Proceedings of the 31st Annual Conference on Ceramics, Metal & Carbon Composites, Materials and Structures*, Cape Canaveral, Florida, January 2007.
- Morscher, G.N.; Yun, H.M.; and DiCarlo, J.A.: "In-Plane Cracking Behavior and Ultimate Strength for 2D Woven and Braided Melt-Infiltrated SiC/SiC Composites Tensile Loaded in Off-Axis Fiber Directions", J. Am. Ceram. Soc. 90 (2007).

(4) I am familiar with, and an expert in, the field of composite structures through my over 40 years of work on the deformation and fracture mechanisms of structural materials.

(5) I am aware that this declaration will be filed in the U.S. Patent and Trademark Office, in order to further prosecution of the above identified United States patent application. I offer the following remarks as an objective analysis of the subject matter of the present patent application with respect to the disclosure of the specification.

(7) I have read and understand the subject patent application. I fully understand the method disclosed in the specification and recited in the claims of the present invention. I am of the opinion that the method for producing high-strength ceramic fibers and ceramic fiber architectural performs with an in-situ grown coating on each fiber surface with a composition different that that of a bulk fiber, as recited in the presently

pending claims 3-5, 8, 10-13 and 28-36 of this application, is fully disclosed and enabled by the present specification.

(8) I understand that the Office Action took the position on pages 2 and 3 that the present specification allegedly fails to describe the subject matter of claims 33-36 "in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention." However, I respectfully disagree with the Office Action's assertion. I respectfully submit that the present specification discloses the claimed features for at least the reasons presented below.

(9) The features of claims 34-36 are described in the present specification in such a way as to reasonably convey to one skilled in the relevant art the recitations thereof. Claim 34 recites, in part, "depositing a thin interphase coating on the treated fibers within the sample by chemical vapor infiltration". The present application discusses that in some embodiments, "batch processing using thermal treatment at one atmosphere pressure for the maximum time-temperature conditions of one hour and 1800°C" is performed (see, for example, paragraph [0050]). The present application then discusses that "an 8-ply stack of SYLRAMIC-iBN fabric" was formed and provided to composite vendors (see, for example, paragraph [0054], of the present application). "At the composite vendors, two different types of thin (~0.5 μm) BN-based fiber coatings, A and B, were chemically vapor infiltrated onto the fiber surfaces" (see, for example, paragraph [0055], of the present application). In other words, after thermal treatment during the batch processing, fiber coatings may be chemically vapor-infiltrated onto fiber surfaces.

In this case, the chemical vapor-infiltration was performed by a vendor, such as GE Power Systems Composites, Goodrich, Synterials and COI Ceramics. As such, the present application discusses that the coatings may be deposited on the fibers via chemical vapor infiltration **after** thermal treatment, as claimed, in a manner that reasonably conveys the claimed features to one of ordinary skill in the art.

(10) The features of claim 33 are also described in the present specification in such a way as to reasonably convey to one skilled in the relevant art the recitations thereof. Claim 33 recites, in part, that "during the step of placing the original sample in a processing furnace, additional external reshaping stresses are applied to the sample". I recognize that the Office Action took the position on page 2 thereof that "the specification fails to disclose an *additional* external reshaping stresses are applied to the sample." However, I respectfully submit that the present application reasonably conveys these features.

Paragraph [0053] of the present application states that:

> [A] vane-shaped graphite mandrel was placed inside a 50-mm diameter tubular-shaped 2D-braided SYLRAMIC fiber architecture (Fig. 7(a)), which was then subjected to the high temperature nitrogen conditions that convert the fibers to SYLRAMIC-iBN. The net result was not only complete fiber conversion to SYLRAMIC-iBN, but as shown in Fig. 7(b), the tubular architectural perform was permanently formed into a vane shape after mandrel removal. Thus for complex architectural preforms, this invention can be used to simultaneously improve SYLRAMIC SiC fibers and creep-form the performs into component shapes with no residual elastic stresses remaining in the architectures.

As can be seen, a tubular shaped architectural perform may be permanently formed into a vane shape. This formation inherently requires applying some reshaping stress to the

perform, and a person of ordinary skill in the art would be reasonably informed of this by the above discussion of changing the shape of the architectural perform. Thus, while in a furnace, additional external reshaping stresses may be applied to the sample, so that during the treatment step, these reshaping stresses are allowed to be reduced by creep-relaxation within the ceramic fibers, as claimed.

(11) Based at least on the above, it is my strong opinion that a person of skill in the art would be reasonably informed of the features recited in claims 33-36 from the present specification.

(12) If the Examiner would like to discuss the above statements, I am willing to conduct a telephone Interview with the Examiner and my legal representative to further discuss why the features of the claimed invention are reasonably discussed in the present application.

(13) I further declare that all statements made herein are true to the best of my own knowledge and belief, and all information contained herein is believed to be true. Furthermore, these statements are made with the knowledge that willful false statements and intentionally deceptive statements so made are punishable by fine or imprisonment or both under §1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the subject patent application, or of any patent issuing thereon.

Respectfully submitted,

8/15/08
(Date)

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